

# Wind Energy for Mining Applications

## ***What is wind energy?***

Wind is created by uneven heating of the earth's surface by the sun. The heat absorbed at the earth's surface is transferred to the air causing differences in local air temperature, density, and pressure. This causes forces that move air around (i.e., wind) and results in the wind energy that can be extracted for useful purposes.

## ***Where is wind energy?***

Wind can be found everywhere on the earth at some time. Since it is generated through solar effects on the earth's surface, wind varies on diurnal cycles as well as seasonally. Wind direction and speed are also affected by local terrain features and can vary considerably over small distances. The wind's power density is dependent upon wind speed (to the third power) and is proportional to the air density. As such, the power that can be extracted from wind increases rapidly with wind speed. Large areas of the country have significant wind energy resources. The best wind resources, like mining resources, are often found in remote areas.

## ***How can wind energy resources be used?***

Wind energy systems convert the kinetic energy of the wind into mechanical energy, which can be used directly for applications such as pumping water, or indirectly, by running a generator to produce electricity. Mining operations are energy intensive and often have high energy costs and/or are located in remote areas where commercial power is either unavailable or too costly to deliver. Diesel electric has



been the traditional solution in this situation. However, in areas where a wind energy resource exists, combined wind and diesel operation has a proven history as compatible power supply systems. In such wind/diesel hybrid systems, the diesel component is highly responsive to wind variations with the only apparent difference on the system (from using diesel power alone), is a significant reduction in fuel consumption. This combination is especially effective when the wind power percentage remains below 40% of total load requirements. Higher wind insertion ratios are feasible, but with increased cost to maintain power quality. Current wind turbines are designed for 20-year

life spans with availability approaching 98%. The wind electric generation cost is on the order of 6-8 cents/kWh, depending primarily on the quality of the wind resource. This is less than the cost of diesel power that averages between 9-19 cents/kWh for prime plants (based on normal capitalization cost and typical fuel costs). Wind provides a direct reduction in operating cost, due to reduced diesel fuel consumption and – in some cases – reduced operating hours of generators. Wind can also be combined with pumped storage hydropower operations to provide power when the wind is not blowing. Such pumped storage genera-

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tion may be attractive where water from mining operations is available and needs to be stored and/or pumped.

### **What are the benefits of wind energy?**

Wind energy systems provide environmentally friendly “green” power that can be used effectively to improve emission characteristics and

to reduce the cost of power generation in remote locations. The air emissions avoided for a typical diesel generator is approximately 1.8 pounds of CO<sub>2</sub> and 0.04 pounds of NO<sub>x</sub> for every kWh of electricity generated by wind. Operating at a typical average capacity of 35%, a 1-MW wind operation will generate 3,066,000 kWh of

electricity per year, avoiding the production of 2,759 tons of CO<sub>2</sub> and 61 tons of NO<sub>x</sub>. In addition to reduced emissions and operating costs, the use of wind energy in mining may also result in improved public perception benefits.

### **For more information**

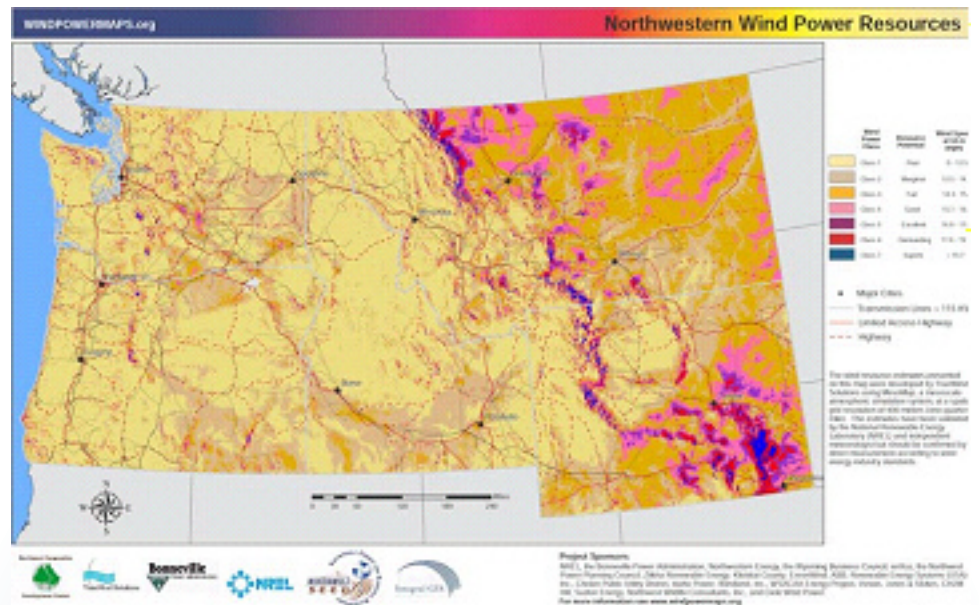
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Idaho National Laboratory (INL) is a U.S. Department of Energy (DOE) national laboratory located in Idaho Falls, Idaho. INL is a leading national laboratory in the DOE Windpowering America activity and has significant capabilities and experience in the integration of wind energy into power systems for remote areas.